The Quantum View of the World

Introduction

1. In November 1979 Prof. D'Espagnat published an article in Scientific American with the title: 'The Quantum Theory and Reality'. The sub-heading read as follows "The doctrine that the world is made up of objects whose existence is independent of human consciousness turns out to be in conflict with QM and with facts established by experiment"

 – Created a furore among physicists. Well what are these experiments which enable us to do experimental metaphysics?

2. On 28th Aug. 1981 The Times carried a report headed "Random events overrun Einstein."

 In what sense is this claim true?

3. Interaction of philosophical and scientific problems in the understanding of QM.

 Book Ex   ← Phil. & Physics   Physics →

 -100 – – -1 0 $+1$ — $+100$

4. Minimal instrumentalist (statistical) Interpretation of QM used by physicists. But Einstein, Schrödinger and Bohr sought to provide a 'conceptual understanding' of

New form

$$\gamma_n = a_n b_n + a_n b_n' + a_n' b_n - a_n' b_n'$$

$$= a_n (b_n + b_n') + a_n' (b_n - b_n')$$

So $\gamma_n = \pm 2$.

$$\frac{1}{N} \sum_{n=1}^{N} \gamma_n = c(a,b) + c(a,b') + c(a'b) - c(a'b')$$

$$\leq 2$$
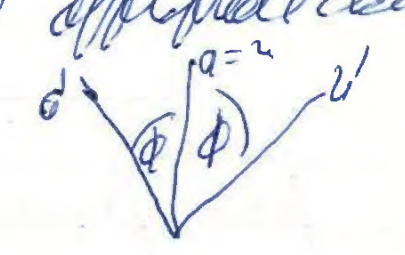
where $c(a,b) = \frac{1}{N} \sum_{n=1}^{N} a_n b_n$, else $c(a,b)$ are correlation coefficients

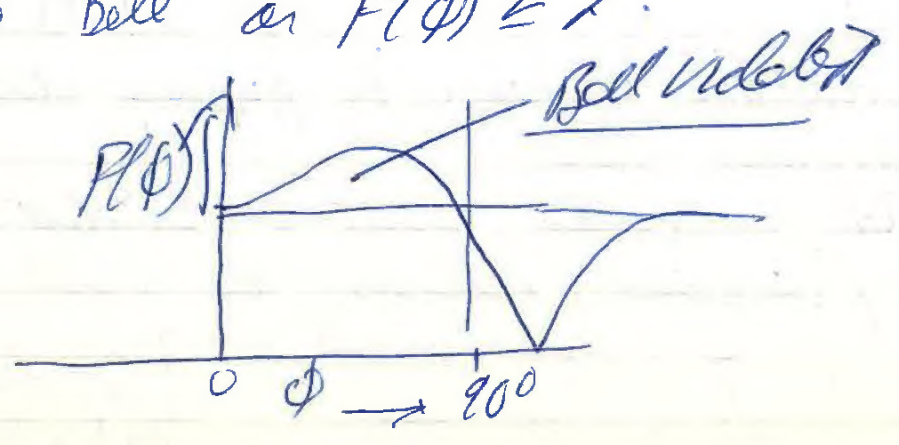$$\overline{a_n b_n} = \text{covariance of random variables } a_n, a_n'$$

(N.B. Correlation Coeff. $= \dfrac{\text{covariance}}{\sqrt{\text{product of variances}}}$

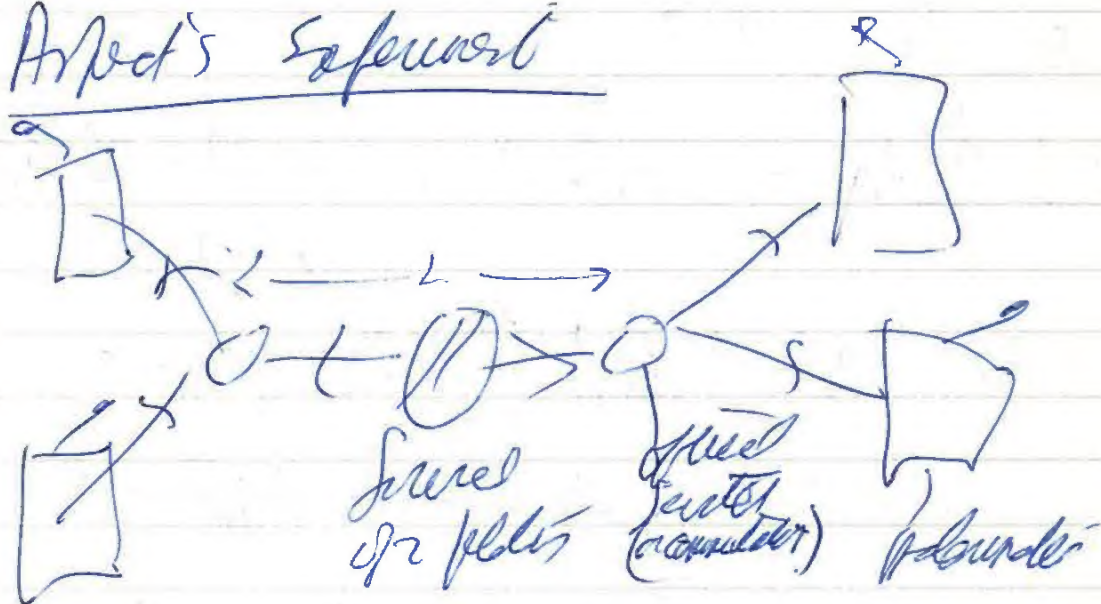in this case variances are all just unity)

Then is the Bell Inequality.

It is violated by QM for appropriate choice of directions a, a', b, b'.

Eg. all directions coplanar

Write Bell as $F(\phi) \leq 2$.

Arbel's Experiment

Source is provided by a very high frequency acoustic wave standing wave induced in a crystal — which behaves as a variable diffraction grating. Modulation frequency is of order 200 MHz.

$$L = 6 \text{ metres} \qquad \frac{L}{c} = 2 \times 10^{-8} \text{ sec}$$
$$= 20 \times 10^{-9} \text{ sec}$$
$$= 20 \text{ nano seconds}$$

laser frequency $\approx \dfrac{10^8}{2} = 50$ Million cycles/sec
$$= 50 \text{ MHz}.$$

NB. Modulation of beam is frequency double that of acoustic wave.

Switch is driven with a random deviation of its frequency between 200, 250 M.Hz.

$$T \approx 0.5 \times 10^{-8} \text{ sec.}$$
$$\frac{1}{2}T \approx 10^{-8} \text{ sec.}$$

So switch changes in $\frac{1}{2}$ + time of flight of photon from source to detector